CLAIMS

What is claimed is:

1. A method for providing a two-stage movement for engagement of an expandable bead molding ring with a sidewall molding plate to form a bead molding pocket in a tire mold within a mold press; wherein a first stage of movement comprises radial expansion of the bead molding ring to form a circumferentially continuous outward-facing bead molding surface that is positioned axially inward of the sidewall molding plate; and a second stage of movement comprises pressing the bead molding ring axially outward to engage the bead molding surface with the sidewall molding plate, thereby forming a bead molding pocket for molding a green tire bead; the method comprising the steps of:

using axial movement of the mold press to cause both the first stage and the second stage of movement;

resisting the first stage of movement with a first set of springs;

providing first stopping surfaces for halting the first stage of movement when the circumferentially continuous outward-facing bead molding surface is formed;

resisting the second stage of movement with a second set of springs;

providing the second set of springs with spring resistance sufficient to prevent axial movement of the bead molding ring until after the first stage of movement is halted by the first stopping surfaces; and

providing second stopping surfaces for halting the second stage of movement when the bead molding pocket has been formed.

2. A method according to claim 1, further comprising the step of:

providing a cam surface on the bead molding ring for dividing an axial force from the mold press into radial force components and axial force components for causing corresponding radial movements and axial movements of the bead molding ring.

3. A method according to claim 1, further comprising the steps of:

using the second set of springs to cause axial disengagement of the bead molding surface from the sidewall molding plate when axial movement of the mold press removes force from the second set of springs; and

using the first set of springs to cause radial retraction of the bead molding ring when axial movement of the mold press removes force from the first set of springs.

4. An expandable bead molding ring assembly for a tire mold in a mold press that is configured to mold a green tire comprising a tread, two beads, and two sidewalls extending

between the beads and the tread; the expandable bead molding ring assembly characterized by:

a first annulus that is a segmented bead molding ring, comprising a plurality of segments that radially expand to form a circumferentially continuous radially outward-facing surface for molding one of the beads, and a radially inner frustraconical cam surface for dividing axially-directed forces into a radial force component and an axial force component;

a second annulus, concentric and axially adjacent to the first annulus, that is a top spring plate, comprising radially-oriented radial springs that are attached to all of the plurality of segments for controlling radial movement of the plurality of segments; and

a third annulus, concentric and axially adjacent to the second annulus, that is a bottom spring plate, comprising axially-oriented axial springs acting between the second annulus and the third annulus for controlling axial movement of the plurality of segments.

5. An expandable bead molding ring assembly according to claim 4, characterized by:

a fourth annulus having a frustraconical radially outer cam surface that is complementary to the radially inner cam surface of the first annulus, wherein:

the fourth annulus is attached to the mold press such that the mold press will impart axially directed movement and axially directed forces to the fourth annulus; and

the radially outer cam surface of the fourth annulus is positioned concentrically within the first annulus such that the radially outer cam surface of the fourth annulus bears on the radially inner cam surface of the first annulus for applying the axially directed forces from the mold press to the cam surface of the first annulus.

6. An expandable bead molding ring assembly according to claim 4, characterized by:

a plurality of tee-shaped guide slots in the first annulus opening toward the adjacent second annulus, wherein a wider crossbar portion of the tee-shape has radially aligned slot guide surfaces; and

a plurality of guide tees protruding from the second annulus toward the adjacent first annulus, shaped and dimensioned to fit inside the tee-shaped guide slots, the guide tees comprising a crossbar having tee guide surfaces complementary to the slot guide surfaces for holding the segments of the first annulus at a fixed axial distance from the second annulus while also allowing the segments to slide radially in and out.

7. An expandable bead molding ring assembly according to claim 4, characterized by:

a plurality of guide bolts that slidingly pass through axially-aligned guide holes in the third annulus and are attached to the second annulus, for holding the second and third annuluses concentric and axially adjacent while guiding movement of the second annulus in an axial-only

direction.

8. An expandable bead molding ring assembly according to claim 7, characterized by:

a bolt head on each guide bolt; and

a cavity that widens each guide hole in the third annulus, such that the bolt head has clearance to move axially within the cavity but limits the axially inward movement of the second annulus that is attached to the guide bolt, when the bolt head stops against the end of the cavity.

9. An expandable bead molding ring assembly according to claim 4, characterized by:

a plurality of spring hooks attached to the segments of the first annulus such that each spring hook extends to a one of the radial springs of the second annulus for interaction whereby the radial springs exert radially-directed force on the segments.

10. An expandable bead molding ring assembly according to claim 9, characterized in that:

the radial springs of the second annulus are held in radially-aligned spring holding holes that have hook slots for providing an opening along a side of each spring holding hole such that a spring hook hooks through the hook slot into the spring holding hole to interact with the radial spring; and

the radial springs exert a radially-inward directed force on the segments of the first annulus.

11. An expandable bead molding ring assembly according to claim 10, characterized in that:

at least one spring hook is used to limit the extent of radial movement of the segments of the first annulus when the spring hook stops against an end of the hook slot.

12. An expandable bead molding ring assembly according to claim 4, characterized in that:

each axially-oriented axial spring has one end seated in a first axial spring pocket in the second annulus, and has an other end seated in a second axial spring pocket in the third annulus, such that the axial springs exert a separating force between the second annulus and the third annulus.

13. An expandable bead molding ring assembly according to claim 4, characterized in that:

half of the plurality of segments of the first annulus are first segments that are complementary to, and circumferentially alternated with second segments;

the first segments are wedge shaped, having circumferentially lateral faces that converge towards a radially outward-facing bead molding surface of the bead molding ring, the first segment lateral faces being planar and oriented in an axial direction; and

the second segments have lateral faces that are complementary to the first segment lateral faces.

14. An expandable bead molding ring assembly according to claim 4, characterized in that:

the first annulus, second annulus, and third annulus are concentric to, and radially within an annular sidewall molding plate;

a fifth annulus that is an adapter plate is concentric, adjacent, and axially outward of the sidewall molding plate; and

the third annulus is attached to the fifth annulus such that a tongue protruding from a radially inner periphery of the fifth annulus is trapped in a groove between flanges and a radially outer periphery of the third annulus.

15. A mold for a green tire comprising a tread, two beads each having a radially inward-facing bead base extending from an axially outer heel to an axially inner toe, and two sidewalls extending between the beads and the tread; the mold comprising:

first and second sidewall plates for molding, respectively, an outer surface of each of the sidewalls plus an axially outer portion of each of the beads approximately in to the heel;

first and second bead molding rings for molding at least the bead bases of the two beads; and

an inflatable vulcanizing membrane for molding the inside surfaces of the tire;

wherein the mold is characterized by:

at least one segmented bead molding ring that is annular and comprises a plurality of segments that radially expand to form a circumferentially continuous radially outward-facing surface for molding one of the beads in cooperation with one of the sidewall plates and the vulcanizing membrane; and a radially inner frustraconical cam surface for dividing axially-directed forces into a radial force component and an axial force component;

an annular top spring plate, concentric and axially adjacent to the segmented bead molding ring, comprising radially-oriented radial springs that are attached to all of the plurality of segments for controlling radial movement of the plurality of segments;

an annular bottom spring plate, concentric and axially adjacent to the top spring plate, comprising axially-oriented axial springs acting between the top spring plate and the bottom

spring plate for controlling axial movement of the plurality of segments; and

an annular lock ring having a frustraconical radially outer cam surface that is complementary to the radially inner cam surface of the first annulus, wherein:

the lock ring is attached to the mold press such that the mold press will impart axially directed movement and axially directed forces to the lock ring; and

the radially outer cam surface of the lock ring is positioned concentrically radially within the segmented bead molding ring such that the radially outer cam surface of the lock ring bears on the radially inner cam surface of the segmented bead molding ring for applying the axially directed forces from the mold press to the cam surface of the segmented bead molding ring.

16. A mold according to claim 15, characterized by:

a plurality of tee-shaped guide slots in the segmented bead molding ring opening toward the adjacent top spring plate, wherein a wider crossbar portion of the tee-shape has radially aligned slot guide surfaces; and

a plurality of guide tees protruding from the top spring plate toward the adjacent segmented bead molding ring, shaped and dimensioned to fit inside the tee-shaped guide slots, the guide tees comprising a crossbar having tee guide surfaces complementary to the slot guide surfaces for holding the segments of the segmented bead molding ring at a fixed axial distance from the top spring plate while also allowing the segments to slide radially in and out.

17. A mold according to claim 15, characterized by:

a plurality of guide bolts that slidingly pass through axially-aligned guide holes in the bottom spring plate and are attached to the top spring plate, for holding the top spring plate and the bottom spring plate concentric and axially adjacent while guiding movement of the top spring plate in an axial-only direction.

18. A mold according to claim 15, characterized by:

a two-stage movement for engagement of the segmented bead molding ring with the tire bead, wherein a first stage of movement comprises radial expansion of the segmented bead molding ring to form the circumferentially continuous outward-facing bead molding surface that is positioned axially inward of the tire bead; and a second stage of movement comprises pressing the segmented bead molding ring axially outward to engage the bead molding surface with the green tire bead and to work with one of the sidewall plates to form a bead molding pocket;

first stopping surfaces for halting the first stage of movement when the circumferentially

continuous outward-facing bead molding surface is formed;

spring resistance in the axial springs sufficient to prevent axial movement of the bead molding ring until after the first stage of movement is halted by the first stopping surfaces; and

second stopping surfaces for halting the second stage of movement when the bead molding pocket has been formed.

19. A mold according to claim 15, characterized by:

a mold assembly for switching in and out of the mold press as a single unit comprising:

the segmented bead molding ring;

the top spring plate that is concentric and axially adjacent to, and assembled axially outward of, the segmented bead molding ring;

the bottom spring plate that is concentric and axially adjacent to, and assembled axially outward of the top spring plate;

an annular adapter plate that is concentric and radially adjacent to, and assembled radially outward of, the bottom spring plate; and

one of the sidewall plates that is concentric and axially adjacent to, and assembled axially inward of the adapter plate.

20. A mold according to claim 19, characterized in that:

the adapter plate is removably attached to the bottom spring plate by means of a tongue protruding from a radially inner periphery of the adapter plate to be trapped in a groove between flanges and a radially outer periphery of the bottom spring plate; and

the adapter plate has an annular registration lip protruding axially toward the adjacent one of the sidewall plates for holding the one of the sidewall plates concentrically aligned to the adapter plate.